REMARKS

The specification has been revised to correct several minor self-evident errors in grammar and spelling.

Turning to the claims, Claims 17, 20, 21, and 23 have been amended. Claims 26 - 35 have been added to claim the invention with more particularity. No claims have been cancelled. Accordingly, Claims 1 and 3 - 35 are now pending.

The revision to Claim 21 corrects its dependency. One of the revisions to Claim 23 corrects a self-evident grammatical error. The other revision to Claim 23 removes one of its limitations. This limitation has been transferred to new dependent Claim 26.

Claims 17 and 20 have been rejected under 35 USC 112 as containing subject matter not described in the specification in such a way as to enable a person skilled in the art to make and/or use the invention. This rejection is respectfully traversed in view of the revisions to Claims 17 and 20.

Claims 17 and 20, as amended, respectively recite:

> 17. The method of Claim 8 wherein:
>
> the body comprises (a) a region consisting largely of silicon and (b) a silicon oxide layer situated along the silicon region; and
>
> the reacting act includes causing oxygen in the silicon oxide layer to be dissolved by titanium of the titanium layer.
>
> 20. The method of Claim 18 wherein:
>
> the first region comprises (a) a substrate region consisting largely of silicon and (b) a silicon oxide layer extending along the silicon substrate region at least at the bottom of the opening; and
>
> the reacting act includes causing oxygen of the silicon oxide layer at the bottom of the opening to be dissolved by titanium of the titanium layer.

Each of Claims 17 and 20 depends (directly or indirectly) from independent Claim 8 which specifies that a titanium layer is formed over a cobalt layer formed over a silicon-containing body and that cobalt of the cobalt layer is reacted with silicon of the body to form a cobalt silicide layer. Claims 17 and 20 each further provide that (a) the body contains a largely silicon region and an overlying silicon oxide layer and (b) the reacting act includes causing oxygen in the silicon oxide layer to be dissolved by titanium of the titanium layer. Since the titanium layer is formed over the cobalt layer, Claims 17 and 20 each require that silicon of a silicon oxide layer be dissolved by titanium of a titanium layer during the

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formation of cobalt silicide from a cobalt layer situated between the titanium and silicon oxide layers.

With respect to Claims 17 and 20, the Examiner alleges on page 2 of the Office Action that "The as-filed specification neither teaches nor suggests how the reacting act would cause *oxygen in the silicon oxide layer* to dissolve in the *titanium* layer" and that "In particular, the instant invention merely teach depositing the cobalt layer (120) on the silicon oxide layer (320); and depositing the titanium layer (130) on the cobalt layer (120)". The Examiner then says that "How can the oxygen in the silicon oxide layer (320) dissolve in the titanium layer (130) when the titanium layer (130) does *not contact* with the silicon oxide layer (320)?".

The sentence which bridges pages 3 and 4 of the specification parenthetically states that "the native oxide tends to be dissolved by the titanium atoms diffusing through [emphasis added] the cobalt layer". That is, oxygen in the silicon oxide layer is dissolved by titanium which is provided from the titanium layer and which diffuses through the cobalt layer. The fact that the cobalt layer initially separates the titanium layer from the silicon oxide layer does not prevent titanium of the titanium layer from dissolving oxygen of the silicon oxide layer.

Claims 17 and 20 have been revised to recite that oxygen in the silicon oxide layer "is dissolved by titanium of" the titanium layer. These revisions are supported by the sentence bridging pages 3 and 4 of the specification. Consequently, the 35 USC 112 non-enablement rejection of Claims 17 and 20 should be withdrawn.

Claims 1, 4, 6 - 8, 11, 12, and 14 - 20 have been rejected under 35 USC 103(a) as obvious based on Hu, U.S. Patent 6,392,302, in view of Fortin, U.S. Patent 6,503,824. This rejection is respectfully traversed.

Independent Claims 1 and 8 are repeated below:

> 1. A method for forming cobalt suicide on a body which has a surface that comprises silicon, the method comprising:
>
> forming a cobalt layer on said surface;
>
> forming a titanium layer over the cobalt layer by ionized physical vapor deposition while the body is attached to a support biased with an AC power of 0 W;
>
> reacting the cobalt with the silicon to form cobalt suicide; and

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removing the titanium layer, and if any cobalt has not reacted with the silicon then removing the unreacted cobalt.

8. A method comprising:

forming a cobalt layer over a body that comprises silicon;

forming a titanium layer over the cobalt layer by ionized physical vapor deposition;

reacting cobalt of the cobalt layer with silicon of the body to form a cobalt silicide layer; and

substantially removing the titanium layer and any unreacted cobalt of the cobalt layer.

Claims 1 and 8 both require that the titanium layer be formed by ionized physical vapor deposition.

Hu discloses a semiconductor fabrication technique in which a cobalt layer is deposited by physical vapor deposition, preferably sputtering, over an upper polysilicon layer of a gate stack suitable for use in an integrated circuit such as dynamic random-access memory. A titanium layer is deposited on Hu's cobalt layer. An anneal is performed to create a cobalt silicide layer from cobalt in the cobalt layer and silicon in the upper polysilicon layer. The titanium layer and any unreacted cobalt are subsequently removed.

On page 3 of the Office Action, the Examiner alleges that "Hu does teach that the titanium layer 28 is formed by a physical vapor deposition (PVD) but does not expressly teach that the PVD is an ionized physical vapor deposition (IPVD) and the body is attached to a support biased with an AC power of 0 W".

The Examiner appears to have misread Hu in making the preceding allegation. While Hu specifies at col. 4, lines 37 - 39, that physical vapor deposition is utilized to form cobalt layer 26, Hu does not appear to disclose how titanium layer 28 is formed. At col. 4, lines 39 and 40, Hu simply states that "A thin (approximately 100 Å) layer 28 of titanium is also deposited" without identifying any technique used to form titanium layer 28. Nowhere else does Hu appear to disclose how its titanium layer is formed. Accordingly, Hu does not disclose that its titanium layer is formed by physical vapor deposition.

Fortin discloses the formation of a titanium layer by ionized physical vapor deposition in multiple stages where the bias applied to the support for the structure that receives the titanium layer is lower at an earlier stage in the deposition process than at a later

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stage in the deposition process. Controlling the bias in this way reduces resputtering that could damage the structure containing the titanium layer.

For a document to be used as prior art in an obviousness rejection under 35 USC 103(a), the document must qualify as prior art under one or more of sections a, b, and d - g of 35 USC 102. Also, to the extent that a document may initially seem to qualify as prior art only under one or more of sections e - g of 35 USC 102, the document must not be disqualified as prior art under 35 USC 103(c).

To qualify as prior art under 35 USC 102(a) with respect to a claim of a U.S. patent application, a document must be published before the date of the claimed invention. The invention date is, at the latest, the filing date of the application. To qualify as prior art under 35 USC 102(b) with respect to a claim of a U.S. patent application, a document must be published at least one year before the filing date of an application. Hence, any document published after the filing date of a U.S. patent application does not qualify as prior art under 35 USC 102(a) or (b) with respect to a properly supported claim of the application.

The present application was filed 23 January 2002. Fortin issued 7 January 2003. Since Fortin's 7 January 2003 issue date is later than the 23 January 2002 filing date of the present application, Fortin does not qualify under 35 USC 102(a) or (b) as prior art for use under 35 USC 103(a) against any claim of the present application.

Insofar as the application for the Fortin patent might have been published under 35 USC 122 and the published Fortin application might qualify as prior art to the present application under 35 USC 102(a) or (b), 35 USC 122 provides that, in the absence of a non-publication request or an earlier publication request, a U.S. patent application is to be published eighteen months after the application's filing date provided that the application is then pending. The application for the Fortin patent was filed 12 October 2001. Eighteen months after Fortin's filing date is 12 April 2003 at which time the Fortin application had issued into U.S. Patent 6,503,824. Accordingly, Fortin would not have been published at the normal eighteen-month date after the filing of the Fortin application.

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Applicants' Attorney is unaware of any earlier publication of the application for the Fortin patent. As far as Applicants' Attorney can determine, neither Fortin itself nor any published version of the Fortin application qualifies under 35 USC 102(a) or (b) as prior art for use under 35 USC 103(a) against any claim of the present application.

35 USC 102(d) is not applicable to Fortin because it is a U.S. patent. This only leaves sections e - g of 35 USC 102 as potential bases by which Fortin might qualify as prior art for use under 35 USC 103(a) against the claims of the present application.

35 USC 103(c) specifies that material which qualifies as prior art only under one or more of sections e - g of 35 USC 102 shall not preclude patentability of a U.S. patent application when that material and the invention claimed in the application were commonly owned at the time of the invention. The Fortin patent is assigned to Mosel Vitelic, Inc., the same party to which the present application is assigned. See the enclosed copy of the assignment of the present application to Mosel Vitelic, Inc. The assignment of the Fortin patent to Mosel Vitelic, Inc., is recorded at Reel 12266, Frame 0586, in the PTO while the assignment of the present application to Mosel Vitelic, Inc., is recorded at Reel 12540, Frame 0638, in the PTO. Insofar as sections e - g of 35 USC 102 are concerned, Fortin is therefore disqualified under 35 USC 103(c) from being used as prior art against any claim of the present application.

The net result is that Fortin does not qualify as prior art under any of sections a, b, and d - g of 35 USC 102 with respect to the present application. Hence, Fortin is not prior art for use in a 35 USC 103(a) obviousness rejection of any claim of the present application.

As mentioned above, each of independent Claims 1 and 8 requires that the titanium layer be formed by ionized physical vapor deposition. Hu does not disclose that its titanium layer is formed by physical vapor deposition, let alone by ionized physical vapor deposition. Consequently, neither of Claims 1 and 8 is obvious based solely on Hu. Since Fortin is not prior art to the present application and thus is not prior art to Claim 1 or 8, Claims 1 and 8 are patentable over the properly appliable art, i.e., Hu.

Claims 4, 6, and 7 all depend (directly or indirectly) from Claim 1. Claims 11, 12, and 14 - 20 all depend (directly or indirectly) from Claim 8. Hence, dependent Claims 4, 6, 7, 11, 12, and 14 - 20 are patentable over Hu for the same reasons as Claims 1 and 8.

Furthermore, Hu does not disclose the further limitation of any of Claims 4, 11, 12, 14, and 15. Accordingly, Claims 4, 11, 12, 14, and 15 are separately allowable over Hu.

Claims 3, 5, 13, 21, and 22 have been rejected under 35 USC 103(a) as obvious based on Hu and Fortin taken with D'Couto et al. ("D'Couto"), U.S. Patent 6,342,133. This rejection is respectfully traversed.

D'Couto discloses a semiconductor fabrication technique in which a titanium layer is deposited by sputtering titanium atoms and ions into an opening in a body. In one

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embodiment, the titanium layer extends out of the opening and is covered in sequence by a titanium nitride layer, an aluminum layer, and another titanium layer. In another embodiment, the titanium layer is situated only at the bottom of the opening and is covered in sequence by a titanium layer and a tungsten region that fills the remainder of the opening.

Claims 3 and 5 both depend from Claim 1. Claims 13, 21, and 22 all depend (directly or indirectly) from Claim 8. For the reasons presented above in connection with independent Claims 1 and 8, Fortin is not prior art to the present application and thus is not prior art to any of Claims 3, 5, 13, 21, and 22.

The remaining two references applied against Claims 3, 5, 13, 21, and 22 are Hu and D'Couto. As mentioned above, Hu does not disclose how its titanium layer is formed. Although D'Couto discloses the formation of a titanium layer by sputtering titanium atoms and ions, nothing in Hu and D'Couto would provide a person skilled in the art with any suggestion or incentive for utilizing ion sputtering to create the titanium layer in Hu. Claims 1 and 8 are thus patentable over Hu and D'Couto. Since Claims 3, 5, 13, 21, and 22 all variously depend from Claims 1 and 8, Claims 3, 5, 13, 21, and 22 are patentable over Hu and D'Couto for the same reasons as Claims 1 and 8.

Claims 9 and 10 have been rejected under 35 USC 103(a) as obvious based on Hu and Fortin taken with Liu et al. ("Liu"), U.S. Patent 6,329,277. This rejection is respectfully traversed.

Liu discloses a semiconductor fabrication technique in which a layer of reducing material is deposited on a native layer of silicon oxide situated along a silicon-containing body. The reducing material consists of one or more of tantalum, magnesium, aluminum, and calcium. A cobalt layer is deposited on the reducing material layer. An anneal is performed (a) to react cobalt of the cobalt layer with silicon of the body to form a cobalt silicide layer and (b) to

cause the reducing material to reduce the native oxide layer. Liu reports that the reducing material, including the reduced oxygen, diffuses through the cobalt layer to its upper surface during the anneal. The reducing material is then removed along with any unreacted cobalt.

Claims 9 and 10 both depend (directly or indirectly) from Claim 8. For the reasons presented above in connection with Claims 1 and 8, Fortin is not prior art to dependent Claim 9 or 10.

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The remaining two references applied against Claims 9 and 10 are Hu and Liu. Nothing in Hu and Liu would provide a person skilled in the art with any suggestion or motivation for using ionized physical vapor deposition to create Hu's titanium layer. Claim 8 is thus patentable over Hu and Liu. Inasmuch as Claims 9 and 10 both depend from Claim 8, Claims 9 and 10 are patentable over Hu and Liu for the same reasons as Claim 8.

Claims 23 - 25 have been rejected under 35 USC 103(a) as obvious based on Hu and Fortin taken with "applicants' admitted prior art", presumably the material disclosed in the Background section of the present application at pages 1 and 2. This rejection is respectfully traversed.

The starting point for the Background material disclosed on pages 1 and 2 of the specification is an insulated-gate field-effect transistor having a single doped polysilicon gate electrode and a pair of doped monocrystalline silicon source/drain regions. A cobalt layer is sputter deposited on top of the structure. A titanium layer is sputter deposited on the cobalt layer. An anneal is performed to create a cobalt silicide layer from cobalt in the cobalt layer and silicon in the gate electrode and the source/drain regions. The titanium layer and any unreacted cobalt are subsequently removed.

Claims 23 - 25 all depend (directly or indirectly) from Claim 8. Fortin is not prior art to any of dependent Claims 23 - 25 for the reasons presented above in connection with Claims 1 and 8.

The remaining material applied against Claims 23 - 25 is Hu and the material described in the Background section of the present application. Nothing in Hu and the application's Background section would provide a person skilled in the art with any suggestion or incentive for employing ionized physical vapor deposition to form Hu's titanium layer. Consequently, Claim 8 is patentable over Hu taken with the application's Background material. Since Claims 23 - 25 depend from Claim 8, Claims 23 - 25 are patentable over Hu and the application's Background material for the same reasons as Claim 8.

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Furthermore, Claims 23 and 24 each recite that the body includes an electrically erasable read-only memory ("EPROM") region. As is well known, EPROMs employ variable-threshold field-effect transistors, typically floating-gate transistors. Nowhere does the Background section of the present application disclose a variable-threshold field-effect transistor such as a floating-gate transistor. Consequently, the application's Background section does not disclose, or deal with, an EPROM region as specified in Claims 23 and 24.

Even if there were some rationale by which the Background material of the present application could be applied to Hu for making Claim 8 obvious, the combination of Hu and the material in the application's Background section would not teach the full subject matter of Claim 23 or 24. This is a separate reason why Claims 23 and 24 are patentable over Hu taken with the material in the application's Background section. The same applies to Claim 25 since it depends from Claim 24, and to new Claim 26 since it depends from Claim 23.

New Claims 27 - 35, which depend (directly or indirectly) from Claim 8, are directed to applying the method of Claim 8 to the formation of a floating-gate transistor such as that used in an EPROM. Claim 27 recites that the body includes a floating gate overlying a doped monocrystalline silicon substrate, a control gate overlying the floating gate, and electrically insulating material that surrounds the floating gate and separates the gates from each other and from the substrate. Claims 28 - 35 all depend (directly or indirectly) from Claim 27 and thus incorporate the floating-gate limitation of Claim 27.

None of the references and other material applied against Claims 1 and 3 - 25 discloses a floating-gate transistor having a floating gate and a control gate as recited in Claim 27 and thus also covered in Claims 28 - 35. This includes Fortin which, for the reasons presented above in connection with Claims 1 and 8, is not prior art to any of Claims 27 - 35. Consequently, Claims 27 - 35 are patentable over all the references and other material variously applied against Claims 1 and 3 - 25.

In summary, the 35 USC 102 non-enablement rejection of Claims 17 of 20 should be withdrawn. Claims 1 and 3 - 35 have been shown to be patentable over the properly appliable art. Accordingly, Claims 1 and 3 - 35 should be allowed so that the application may proceed to issue.

Please telephone Attorney for Applicant(s) at 650-964-9767 if there are any questions.

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Respectfully submitted,

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APPENDIX A

PARAGRAPHS 8, 32, AND 35,
WITH ANNOTATIONS TO INDICATE REVISIONS,
OF SPECIFICATION OF
U.S. PATENT APPLICATION 10/056,154,
ATTORNEY DOCKET NO. M-12524 US

[0008] In some embodiments of the invention, the titanium is deposited by ionized physical vapor deposition [process] ("ionized PVD"). An ionized PVD chamber includes an induction coil positioned between the titanium target and the wafer. The coil is energized with an AC current to densify the plasma in the chamber. As the sputtered titanium atoms move towards the wafer, some of the titanium atoms become ionized due to the coil energy. The pedestal holding the wafer is also biased with an AC current to attract the titanium ions and cause them to approach the wafer at an angle closer to 90°. See "Handbook of Semiconductor Manufacturing Technology" (edited by Yoshio Nishi et al., 2000), pages 406-407, incorporated herein by reference. Better step coverage is achieved at the bottom of the openings because the ions approaching the wafer at the angles near 90° are less likely to create overhangs near the top of the openings.

[0032] Dielectric 534 (Figs. 7A, 7B) on the sidewalls of stacks 532 insulates the control and floating gates from polysilicon wordlines 536. In some embodiments, dielectric 534 includes silicon dioxide (not separately shown) formed on the sidewalls of polysilicon 524, 528, and also includes an outer layer consisting of silicon nitride spacers which **overlie** [overly] the silicon dioxide. A thin silicon dioxide layer 535 (Fig. 7A) is formed on the substrate under the dielectric 534.

[0035] A thin silicon dioxide layer 550 is shown to **overlie** [overly] the bitline regions 542. This layer is removed during the formation of the contact openings for contacts 548.

APPENDIX B

CLAIMS 17, 20, 21, AND 23, WITH ANNOTATIONS TO INDICATE REVISIONS, OF U.S. PATENT APPLICATION 10/056,154, ATTORNEY DOCKET NO. M-12524 US

17. (Amended) The method of Claim 8 wherein:

the body comprises (a) a region consisting largely of silicon and (b) a silicon oxide layer situated along the silicon region; and

the reacting act includes causing oxygen in the silicon oxide layer to **be dissolved by titanium of** [dissolve in] the titanium layer.

20. (Amended) The method of Claim 18 wherein:

the first region comprises (a) a substrate region consisting largely of silicon and (b) a silicon oxide layer extending along the silicon substrate region at least at the bottom of the opening; and

the reacting act includes causing oxygen of the silicon oxide layer at the bottom of the opening to **be dissolved by titanium of** [dissolve in] the titanium layer.

21. (Amended) The method of Claim **18** [8] wherein the opening has an aspect ratio of at least 1.3.

23. (Amended) The method of Claim 8 wherein:

the body comprises an erasable programmable read-only memory region; and

the cobalt silicide layer is formed to contact a doped [monocrystalline] silicon section of **the** erasable programmable read-only memory region.

COPY

Attorney Docket No.: M-12524 US

ASSIGNMENT

For good and valuable consideration, receipt of which is hereby acknowledged, we

Vincent Fortin of Santa Clara, CA
Kuei-Chang Tsai of San Jose, CA

hereby sell, assign and transfer to Mosel Vitelic Corporation, a Taiwan corporation, having a place of business at No. 19 Li Hsin Road, Science Based Industrial Park, Hsin Chu City, Taiwan, its successors and assigns, the entire right, title and interest throughout the world in our invention in:

COBALT SILICIDE FABRICATION METHODS THAT USE PROTECTIVE TITANIUM LAYERS

for which we have executed a United States patent application on or about the date of this assignment, and all patent applications and patents of every country for said invention, including divisions, reissues, continuations and extensions thereof, and all rights of priority resulting from the filing of said applications; we authorize the above-named assignee to apply for patents of foreign countries for said invention, and to claim all rights of priority without further authorization from us; we agree to execute all papers useful in connection with said United States and foreign applications, and generally to do everything possible to aid said assignee, their successors, assigns and nominees, at their request and expense, in obtaining and enforcing patents for said invention in all countries; and we request that the United States Patent and Trademark Office issue all patents granted for said invention to the above-named assignee, its successors and assigns.

Executed this 23 day of JANUARY, 2002.

Vincent Fortin

State of California)
) ss.
County of Santa Clara)

On January 23, 2002 before me, Darci J. Sakamoto personally appeared Vincent Fortin personally known to me or proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is(~~are~~) subscribed to the within instrument and acknowledged to me that he/~~she/they~~ executed the same in his/~~her/their~~ authorized capacity(~~ies~~), and that by his/~~her/their~~ signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

DARCI J. SAKAMOTO
Commission # 1273498
Notary Public - California
Santa Clara County
My Comm. Expires Aug 11, 2004

SIGNATURE OF NOTARY

Executed this 23 day of Jan., 2002.

Kuei-Chang Tsai

State of California)
) ss.
County of Santa Clara)

On January 23, 2002 before me, Darci J. Sakamoto personally appeared Kuei-Chang Tsai personally known to me or proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is(~~are~~) subscribed to the within instrument and acknowledged to me that he/~~she/they~~ executed the same in his/~~her/their~~ authorized capacity(~~ies~~), and that by his/~~her/their~~ signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

Darci J. Sakamoto
SIGNATURE OF NOTARY

839070

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Commission # 1273498
Notary Public - California
Santa Clara County
My Comm. Expires Aug 11, 2004